factors. If the principles can be applied to the development of will power and co-ordination, why not to memory, association, imagination, and reasoning as well? All have a physiological basis, and in so far all are governed, in a given individual, by the same principles of growth. There is at least a wide field here for inquiry and practical investigation. There can be no doubt that the present system of secondary and collegiate instruction, which requires an equal amount of work from all pupils, causes much harm to many individuals. Mr. Davis's results emphasise the importance of recognising the individual in the training of either physical or mental ability.

AN elementary text-book of zoology, which has been prepared for the Cambridge Natural Science Series by Mr. A. E. Shipley of Cambridge and Prof. MacBride of McGill University, Montreal, will be published on September 9 by the University Press in England and the Macmillan Co. in New York.

A CATALOGUE of works on chemistry and chemical technology in the library of the Patent Office has just been published as No. 6 of the Patent Office Library Series. The list comprises the titles of 885 works (79 serials, 806 text-books, &c.), representing about 3300 volumes. The titles are classified under 146 headings and sub-headings, so that students using the Patent Office library can readily find the works available upon any subject in chemistry.

THE United States Board on Geographic Names has issued a special report giving the accepted spellings of 4000 geographical words used in the Philippine Archipelago. When the islands were acquired by the United States in 1898, and new charts had to be prepared, much confusion existed as to the geographical orthography—Spanish, Malay, American and English methods of spelling native names being in use. Acting upon the advice of the Board, the U.S. Hydrographic Office adopted the spelling upon the best Spanish official charts and maps, and a list of about 4000 coastwise names was compiled, chiefly from Spanish sources. This is the list which has now been published. Another list, containing about 6000 Philippine geographical names, was prepared independently by Father Algue, director of the Jesuit Observatory at Manila, and these have been accepted by the U.S. Coast and Geodetic Survey for the atlas of the Philippine Islands shortly to be issued. To ensure uniformity, Father Algue has revised the present list, so that all the names in it now agree with those used in the Coast Survey atlas.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mr. H. S. Kemp; a Japanese Deer (*Cervus sika*) from Japan, presented by Sir Douglas Brooke, Bart.; a Short-headed Phalanger (*Petaurus breviceps*) from Australia, presented by Captain Gordon Wilson; two Common Kingfishers (*Alcedo ispida*), British, presented by Mr. W. Milne; two Rosy-faced Love-birds (*Agapornis roseicollis*) from South Africa, presented by Mrs. Harry Blades; an Alligator (*Alligator mississippiensis*) from Southern North America, presented by Mr. J. Foster Spence; a New Zealand Parrakeet (*Cyanorhamphus novae-zealandiae*), a One-wattled Cassowary (*Casuarius uniappendiculatus*), a Westermann's Cassowary (*Casuarius westermanni*) from New Guinea, two White-breasted Sea Eagles (*Haliastur leucosternus*) from Australia, an Angulated Tortoise (*Testudo angulata*) from South Africa, two Pale-headed Tree Boas (*Epicrates angulifer*) from Cuba, a Common Roe (*Capreolus caproea*), European, two Getulian Ground Squirrels (*Xerus getulus*) from Morocco, deposited; a Spot-wing (*Psaroglossa spiloptera*) from India, purchased; a Burrhel Wild Sheep (*Ovis burrhel*), an Axis Deer (*Cervus axis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN SEPTEMBER.

Sept. 1.	7h. 36m. Minimum of Algol (β Persei).
4.	16h. 2m. to 16h. 58m. Moon occults ϵ Tauri (mag. 3·7).
6.	10h. 48m. to 11h. 13m. Moon occults 71 Orionis (mag. 5·1).
7.	Pallas in opposition to the sun.
9.	14h. 32m. to 15h. 25m. Moon occults κ Cancri (mag. 5·0).
12.	Perihelion passage of Encke's comet.
15.	Venus. Illuminated portion of disc = 0·795.
15.	Mars. ,, ,, ,, = 0·933.
15.	15h. Venus in conjunction with the moon. Venus 1° 15′ N.
18.	12h. 30m. Minimum of Algol (β Persei).
21.	9h. 19m. ,, ,, ,,
27.	6h. 5m. to 9h. 13m. Transit of Jupiter's Satellite III.
28.	6h. 1m. to 6h. 41m. Moon occults 62 Piscium (mag. 6·0).

NEW ELEMENTS OF COMET 1901 (I.).—From observations made in May and June at the Cape and Cordoba (*Astronomische Nachrichten*, Bd. 156, No. 3734), Herr H. Thiele has computed a new set of elements for this comet, giving the following orbit:—

$$T = 1901 \text{ April } 24{\cdot}28845 \text{ Berlin M.T.}$$

$$\left.\begin{array}{rcrrr} & & {}^\circ & ' & '' \\ \omega & = & 203 & 2 & 15{\cdot}1 \\ \Omega & = & 109 & 38 & 53{\cdot}1 \\ i & = & 131 & 4 & 49{\cdot}3 \end{array}\right\} 1901{\cdot}0$$

$$\log q = 9{\cdot}388827$$

An ephemeris is also given founded on these revised elements, so that search for the now faint comet may be continued.

Ephemeris for 12h. Berlin Midnight.

1901.		R.A. h.	m.	s.	Decl. °	′	″
Aug.	28	8	36	23·21	+11	1	14·2
Sept.	1		38	55·36	10	58	38·1
	5		41	16·77	10	56	4·5
	9		43	27·06	10	53	38·9
	13		45	25·77	10	51	26·9
	17		47	12·35	10	49	34·0
	21		48	46·28	10	48	6·1
	25		50	7·06	10	47	8·3
	29		51	14·12	10	46	45·9
Oct.	3		52	6·91	10	47	4·2
	7		52	44·72	10	48	8·7
	11	8	53	6·73	+10	50	5·5

BRIGHTNESS OF THE SOLAR CORONA, JANUARY 22, 1898.—In a paper read before the Royal Society, Prof. Turner gives a preliminary description of the results obtained from an investigation into the law of variation of the brightness of the solar corona in relation to the distance from the sun's limb (*Proc.* Roy. Soc., vol. lxviii. pp. 36–44). Instead of the rotating sectors used in previous similar investigations, a graduated gelatine wedge has been employed to diminish the intensity of the comparison beam. An entirely new method has been adopted for representing the results, which has led to the suggestion of a more satisfactory law for the variation of coronal brightness with the distance from the sun.

Up to the present time the relation usually adopted was that formulated by Prof. Harkness in 1878, viz.:—

$$\text{Brightness} \propto \frac{1}{(\text{distance from sun's limb})^2};$$

but this was not in agreement with the visual measures of Thorpe and Abney in 1886 and 1893.

The new relation now suggested is—

$$\text{Brightness} \propto \frac{1}{(\text{distance from sun's } \textit{centre})^6}.$$

Tables giving the measures along six different radii show sufficiently small residuals to warrant the formula being provisionally used to express the variation. It is found that a constant is required to be added to the formula, the physical interpretation of which is most probably the sky-glare present during totality, and which would necessarily give a certain

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amount of light all over the plate. The total brightness of the corona will thus depend on the area of sky included. Assuming this to be a circular area 5° in diameter, the total brightness of the 1898 corona would be about 2·4 times that of full moon, while the 1893 corona was only about 1·1 times brighter than the full moon.

THE SPECTROSCOPIC BINARY "MIZAR."—During March and April of the present year a series of excellent photographs of the spectrum of this star, ζ Ursæ Majoris, were obtained with Spectrograph IV. and the 33 cm. refractor at the Potsdam Observatory. Dr. H. C. Vogel has measured these, and gives the result of the reductions in the *Astrophysical Journal* (vol. xiii. pp. 324-328). On some of the plates as many as sixty-five lines are recognisable, including several of the strongest iron lines and lines of silicon and magnesium. When the period of maximum separation occurs, however, many of these become faint and the measures are more difficult.

On several of the plates the separated magnesium lines at λ 4481 appeared of unequal width, but no change in their behaviour was discernible after a coincidence.

The values of the relative motion are given for twenty-five plates obtained during the period 1901 March 24-May 1, ranging from 158 to 15 kilometres per second.

The motion of the whole system is given as 16 km. per second. A diagram is given showing the velocity curve most nearly representing the final reduced measures, and the period thus deduced is 20·6 days—considerably less than the period of 104 days deduced by Pickering about 1890.

The following provisional elements have been computed from the curve by Lehman-Filhes' method on the assumed values of

Period = 20·6 days.
Maximum relative velocity of A = 128 km.
" " " B = 156 "
T_0 = 1901 March 28·60 (Rel. motion in line of sight = 0).
T = 1901 March 28·88.
$\omega = 101^\circ{\cdot}3$.
$e = 0{\cdot}502$.
$\log \mu = 9{\cdot}4843$.
$\mu = 17^\circ{\cdot}476$.
$a \sin i$ = 35 million kilometres.
$m + m_1 = \frac{4 \odot}{\sin^3 i}$.

NOVA PERSEI.—In the *Astrophysical Journal* (vol. xiii. pp. 336-7) Messrs. G. C. Comstock and J. Stebbins give a very exhaustive series of comparisons of the estimated brightness of Nova Persei from February 24 to May 12. The observations were made by the "grade" method of Argelander, the estimated error being 0·1 magnitude for a single comparison. The rapid variation of the star is well shown by the many cases where several observations were obtained during the same evening. The minimum magnitude recorded is 5·7. Most of the estimates were made with the help of an opera-glass, the comparison stars being those given on Hagen's special chart of the region.

THE FUTURE OF ELECTRIC TRACTION.[1]

IT is not so long since the Englishman, and perhaps more particularly the Londoner, first tasted the sweets of electric traction, but he has already found it so satisfactory, whether as a profitable investment or as a method of travelling at once comfortable, convenient and healthy, that he is clamouring for its rapid extension and development. It is beginning to be realised, too, that electricity as a motive power is not destined to be confined to metropolitan railways and suburban tramways. The electrification of our larger railways is now being discussed as a practical problem by the more far-sighted of our engineers, who have recognised that many of the railway systems characteristic of this country are peculiarly suited for electrical running. Mr. Langdon, now president of the Institution of Electrical Engineers, devoted a paper read last November before that society to the subject; and Major P. Cardew, in his recently delivered Cantor Lectures, again gave prominence to the question.

It is interesting to consider what are the conditions of working which would make a railway one in which the adoption of electric traction is likely to prove profitable, for unless the alteration results in the increased economy of the system it is clear that it is not likely to be made. "Electric traction," says Major Cardew, "tends towards the ideal of the continuously moving platform," and one may say that the more nearly a railway tends towards the same ideal the more likely is the adoption of electricity as its motive power. In those most closely approaching this limit, namely, the metropolitan railways, all other systems at present known have long been seen (by all except perhaps the directors of the London underground and district railways) to be doomed. The reason lies in the essential difference between steam and electric driving, namely, that in the one case the train must carry its own power generator whilst in the other the power is generated in bulk for a number of trains. Since the generation of power in bulk is much cheaper than in detail, the tendency with steam locomotives is to make each detail as large as possible, and therefore to run heavy trains at long intervals. With electric working, on the other hand, it is desirable to make the load on the generating station as constant as possible, which can only be done when the number of trains is large and each only takes a small fraction of the total load; for in such a case the stopping and starting of individual trains will only have a small percentage effect on the output of power. It will readily be seen, therefore, that for long-distance traffic the steam locomotive is likely for some time to come to hold its own, for here the number of passengers is not so great as to be able to support a very frequent service of light trains, and, moreover, the time taken over the journey, being nearly the whole of the day or night, practically fixes the starting times. With lines communicating between important towns not too far apart (about 100 miles is the limit given by Major Cardew), electric traction could be introduced with advantage; in this case a frequent service of light trains would be a great benefit, especially if a number of important centres lie on the route between the termini and if there is a field for metropolitan traffic at the ends of the line. In such lines our small but densely populated country abounds.

Many additional advantages are introduced at the same time as the principal gain in the lessening of the cost of power generation. Thus the driving power can be distributed throughout the train, which results in lessening the wear of the permanent way and also in a lessening of the slip of driving wheels, as a greater proportion of the weight of the train is used for adhesion. It is easier, too, to provide power for accelerating the train and for mounting gradients, as the extra power needed in these cases is derived from an outside source, whereas if a steam engine were made powerful enough for very quick acceleration it would be too powerful for economical working during the greater portion of its running time. The concentration of power generation at a few centres leads to many economies in working expenses; coal and water are only used at the generating station, and it is only there in consequence that means for their storage and handling have to be provided.

Those who are more keenly interested in this question will do well to read the paper by Mr. Langdon to which reference has been made above. They will there find the matter thrashed out in considerable detail, both in the paper itself and in the discussion upon it, with the estimated saving worked out from a consideration of the existing traffic over a section of the Midland Railway, fifty miles long, between London and Bedford. Major Cardew discusses the problem more generally, but in his third lecture enters with some detail into the equipment of an imaginary typical full-scale railway fifty miles long; for this he arranges a suitable time schedule and then estimates the amount of power required and the approximate cost of equipment.

Major Cardew equips his imaginary railway on the polyphase system, which he considers, on account of "the advantages obtained in regard to means of conversion and from the use of higher pressure," to be most suited for use on full-scale railways. Space does not permit us to enter into a discussion of the relative merits of three-phase and direct-current working, and we must content ourselves with referring the interested reader to Major Cardew's lectures, where he will find the question fully considered. Here, in England, we are not very familiar with polyphase currents, but on the Continent, and in Switzerland especially, there are many railways thus equipped, and there can be no question of the willingness of Continental engineers to introduce their wares into this country if, as is to be feared,

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[1] "On the Supersession of the Steam by the Electric Locomotive." By W. Langdon. (*Journal* of the Institution of Electrical Engineers, vol. xxx. p. 124.)

"Electric Traction." By Major P. Cardew. Cantor Lectures. (*Journal* of the Society of Arts, July 12, 19 and 26.)

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